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ABSTRACT

An experimental public school speech therapy program is described, which offers automated, programed instruction in sound production and auditory training. The experiment includes self-teaching methods, as well as utilization of paraprofessional personnel under the supervision of a qualified speech therapist. Although the automated program was presented as a supplement to traditional speech therapy methods, an effort was made to evaluate its contribution to the accomplishment of therapy goals. Utilizing 28 subjects, the investigators compared articulation test scores of those who had received only traditional therapy with those who had received both traditional and automated therapy. Results indicated a significant improvement in articulation with those students who received combined treatment. Although the study was limited, it was felt that automated programming may represent an important instrumentality for accomplishing school therapy objectives. (JB)

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Title Of Project

An Automated And Programmed Laboratory For Instruction In The Areas Of Speech And Communication

Principal Investigators

Thomas Coleman — George Langberg

Implementing Agency

Union Free School District No. 1, Ossining Public Schools

Date

July 10, 1968

Final Report

New York State Experimental And Innovative Programs
Article 73, Section 3602a, Subdivision 14 of the State Education Law

The Research Reported Herein Was Supported By The New York State Education Department, Division Of Research

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ABSTRACT

OF

FINAL REPORT

OF

An Automated And Programmed Laboratory For Instruction In The Areas Of Speech And Communication

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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ABSTRACT

YEAR END FINAL REPORT SCHOOL YEAR 1967 - 8

OF

An Automated And Programmed Laboratory For Instruction In The Areas Of Speech And Communication

Thomas Coleman
George Langberg

Union Free School District 1
Ossining, N.Y.

WITH

New York State Experimental And Innovative Programs

In the past year, a program has been introduced into the Ossining Public Schools designed to provide automated and programmed speech instruction for students with uncomplicated dyslalic disorders. The programs encompassing auditory discrimination and articulatory training are part of a larger effort to provide, through a laboratory center for the areas of speech and communication, a wider and more responsive treatment service.

The programs in auditory training and articulation have now been presented to 110 students, who have received instruction over a five month period. Students have received sixty minutes of instruction per week, provided over three sessions. Because the program could not be formally validated previously, each student was assigned to an additional session of conventional remediation undertaken by an experienced speech therapist.

The programs are informed by a learning theory orientation, dictating certain emphasis in both the discrimination and sound production phases. Discrimination training sequences center initially on the development of sensitization to linguistic and phonetic boundaries so that students are first taught to distinguish the variations of rhythm, stress, and pause that progressively delimit phrase, word, and syllable groupings. The sequence terminates in phonemic differentiation. The discrimination of phoneme differences is approached by a form of pre-training on the dimensions of contrast to which the student must orient for the efficient discernment of the distinctive stimuli involved in the discrimination task. This sequence leads to skill development in the ability to discriminate phonemically correct articulations from phonemic distortions, including those produced by the student himself. The sequence terminates with tasks requiring the student to determine whether a graduated series of phoneme pronunciations approaches or diverges from correctness or distortion of articulation -- a function the student must be able to execute in monitoring his own efforts to more closely approximate a given sound.

The articulation phases of the program emphasizes the deliberate variation of articulatory adjustment during response matching procedures and the use of shaping procedures to attain a modification of existent articulations. Multisensory training in the formulation of appropriate motor

responses and the employment of specific techniques to insure the attachment of responses to articulatory intent and to phonetic cueing constitute significant aspects of the sound production training. During response stabilization instruction, an attempt is made to suspend the stimuli normally reinforcing the misarticulated sound. New articulation responses are therefore first practiced in non-vocalized speech and subsequently in vocalized, but markedly slowed speech. The final automatization of new responses is sought in extensive self-monitoring practice in a variety of naturalistic or simulatory contexts.

The evaluation of the program, was encumbered by the felt necessity for combining the program, in its initial introduction with tradition treatment sessions. Nevertheless, a limited study was undertaken to examine the contribution of the experimental program to the accomplishment of speech therapy goals. Utilizing twenty-eight subjects satisfying multiple selection criteria, a comparison of change scores on structured and free response articulation tests for students receiving traditional therapy and those receiving combined treatment was effected. An analysis of variance of gains indicated that the inclusion of training upon the experimental program resulted in a significant improvement in the development of correct articulatory responses and the realization of their use in connected naturalistic speech, over that accomplished by traditional remediation alone. Since both areas of improvement constitute pre-emptive goals of speech therapy, we feel that the results though tentative and quite limited, are supportive of the hypothesis that automated programming may be a viable approach to some of the problems and needs of school treatment services.

YEAR END REPORT -- SCHOOL YEAR 1967-8

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The work upon which this report is based was supported jointly by the Ossining School Board, and the New York State Education Department under Article 73, Section 3602a, Subdivision 14 of the State Education Law. Agencies undertaking such projects are encouraged to express freely their professional judgement in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official policy of the New York State Education Department.

Implementing Agency

Union Free School District No. 1, Ossining Public Schools

Address

Ossining, New York

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TABLE OF CONTENTS:

Statement of Problem

Description of Program

Objectives of Current Study

Methods and Procedures

Results

Discussion

Summary

Appendix

THE PROBLEM

The following is an interim report covering the first year in the operation of the Speech and Communications Laboratory in the Ossining Public Schools.

The Laboratory is an outgrowth of efforts to react to an increasingly acute demand for professionally trained speech and communication specialists, who, in educational settings have come to share responsibility for the treatment of complex range and variety of expressive language deficits. A growing sophistication with respect to the forms and consequences of communicational disability and an intensification of efforts to respond appropriately to both the culturally conditioned and individually generated needs of pupil populations for such services have created conditions which appear to be beyond the reach of traditional solutions. Accordingly, we have examined the possibilities of utilizing instrumentalities which in the past infrequently applied to clinical treatment situations, to permit a very much wider and varied disbursement of the services of speech and communication therapists. In this, we have come to envision a functioning of such personnel which appears to be more realistically attuned to the magnitude of pupil needs and to the priorities and particular potential of the educational context. In attempting to establish alternative approaches to those of traditional school treatment, we have found it necessary to regard critically assumptions which suggest that the modalities for treatment presentation and the forms of treatment strategy and response are limited to those which may proceed in their entirety by direct, unmediated contact between therapist and student.

Contrastingly, we have presumed that within speech and communication programs certain therapeutic objectives may be efficiently attained by the employment of an available technology to accomplish specific treatment response capabilities, and, most significantly, by the adaptation of specific content to a substantially automated, programmed, and self-instructional modality. Such an approach would appear to offer many advantages which accrue from the enlargement of instructional options. Not the least of these is that the transference of certain limited functions of therapists to programs carried to the student through audio tape and film, is that it permits the therapist some choice in the investiture of his efforts, and some opportunity to meaningfully increase the range and coverage of his remediational service. One of the major

ways in which the development of programs that are in some measure automated and self-instructive facilitate such an increase is that they enable a therapist to employ individuals with lesser training and para-professional status to implement certain delimited functions. The character of the para-professional's contribution must necessarily vary with the form of the therapist's remediational program. We shall outline their responsibilities in the Ossining Laboratory Program as an illustration of their possible functions and as an explication of their role in permitting the operation of a complex and differentiated treatment service.

With the removal of the therapist from a consistently proximate relationship to the remediation process, intuitive, empirical, and unspecified modes of operation must be replaced with a more explicit theory of remediation. We have found it productive, in this regard to utilize the analytic approach to language employed by behavior theorists, particularly in respect to the concepts of response control. By regarding speech as a species of operant behavior with the characteristics of a continuous repertory, a considerable body of information which relates to the elicitation, modification, generalization and extinction of responses becomes pertinent to the development of instructional programs. The approach has, of course, been familiarly associated with self-instructional teaching in cognitive domains but only recently has there been any extrapolation of the behavioral methods to the field of speech and communicational therapy. Program development, however, has now evolved for the treatment of aphasic conditions (Taylor and Sands, 1965), auditory discrimination inadequacy (Holland, 1960; Winita and Preisler, 1967), articulatory defectiveness (Garrett, 1965), verbal primitivity and autistic language failure (Salzinger, et al 1966; Hewett 1965) and non-fluencies of speech (Goldiamond 1964). Holland has pointed out that the behavioral approaches have given indications of significant performance gains in areas most resistant to traditional treatments. In some instances, the elimination of speech difficulties has been accomplished with noteworthy brevity, as in the correction of lateral and frontal lisping (Bloom, 1963, Mowrer, 1967) although the susceptibility of otherspeech responses to rapid modification by behavioral approaches is likely to be variable. A number of studies, however, are generating evidence relating the effectiveness of behavioral approaches to the correction of precisely specified performance inadequacies in the articulation and discrimination of particular phonemes (Shelton, Elbert,

and Arndt 1967, Winitz and Preisler, 1967). Such studies are also explicating the role of programming variables in the establishment of effective training procedures.

PROGRAM DESCRIPTION

Although the Ossining Schools' Speech Communication Laboratory has been involved with the development of program systems designed to fulfill a range of treatment and instructional objectives, the past year's efforts have centered upon the implementation and refinement of a program for general discrimination and articulation development. The program possesses a phasic organization in which training upon the components of auditory and motor discrimination skills is superseded by the shaping of new articulatory responses and by the stabilization and automatization of these responses.

In its objectives the program initially attempts to heighten the children's responsiveness to the patterns of auditory, kinesthetic, and tactile sensations that constitute the contextual background of his articulations. The student is therefore led to explore positions and surfaces within the oral cavity, to kinesthetically estimate the position of the tongue, lip and blade, the mandible and oral aperture, and the movement of the soft palate. The student is asked to produce particular phonemes and is progressively required to focus upon the differentiated tempostructural pattern of motor movements accompanying the articulation. A flexible, moveable model of the oral apparatus is provided in which the student may arrange the positions of the articulators so as to represent his visualization of their relationship. Conversely, he is asked to duplicate by his own response motor spatial relationships exhibited upon the model.

As the image of the oral structure and its mechanisms is consolidated, the programs increasingly emphasize the central role of the student's ability to monitor his own speech. Self-monitoring is approached through the monitoring of the diversity of speech patterns which surround the student, and the program, therefore, presents speech samples which illustrate the variety of such patterns in terms of regionalisms, maturity, intelligibility, and idiosyncracies of articulation and style. As the understanding of the role of monitoring is deepened, units of auditory discrimination are introduced as instrumentalities for the achievement of effective self-regulation. The auditory program closely follows the model for such train-

ing presented by Powers (1957). The units are almost entirely self-instructional. Items have been sequenced on the basis of scaled values for phonemic contrasts (Miller and Nicely, 1955) and further revised from error rate information obtained in earlier pilot studies. Since student abilities vary so extensively in this area, branching to special training procedures have been incorporated into the program. These branched program units particularly emphasize the correlation of cues from available sensory modalities in abetting the discriminative process. The components of phonemic contrast, eg., the stop-continuative and the voiced-voiceless dimensions, are independently featured in a form of pre-training on the basis for contrast judgments. Furthermore, as sensitization to phonetic differences is being developed, identification of the motor dissimilarities involved in the articulation of phonemic pairs is simultaneously stressed by comparison of experienced kinesthetic images, by verbal descriptions of the contrasting movement sequences, by visual exposure to both actual and animated observations of the oral apparatus during the production of the selected sounds, and by experimentation with alteration of the sounds caused by deliberate variation of articulator adjustment. These efforts at the integration of auditory stimuli with their corresponding motor patterns are intended not only to increase the probability of discriminative responses but to avoid the dissociation and failure of inter-sensory processing which the study of apractic disorders (Myklebust,1954) reveals as so profoundly disruptive of adequate articulatory performance. Since the purpose of discrimination training is the development of skill levels adequate to the task of self-monitoring of articulatory performance, emphasis is placed on the ability to analyze words into constituent phonemes and to recognize substitutions and distortions in word and speech contexts. The training tasks require the teaching of word analysis techniques, with initial emphasis upon the auditory recognition of the gross topography of speech units. Hearing patterns of rhythmic stress and phrasing, the location of intervals of silence, alterations of pitch, and natural word cleavages (syllable components) precede efforts to discriminate individual sounds embedded in phonetic structures. Visual stimuli are used to support the efforts at auditory analysis, letters are arrayed before the student and are grouped to correspond to the sound units readily discernible when words are experienced auditorily. As the student gains in auditory analysis skills, he is channeled to material which

is concentrated upon phonemes he misarticulates and for which he is to receive training. He is presented with speech units heavily saturated with the specific phonemes and is asked to identify their occurrence and position. The role of presentation, initially slow, is gradually increased to the speed of normal speech.

As the student's ability to differentiate the sound from context increases, he is introduced to the problem of discriminating the sound from its distortions. The dimensions to which the student must orient in discerning correct from incorrect productions of the phoneme are elaborated. Discriminative skill in identifying phonemic distortions when uttered by an external speaker are followed by the student recording his own responses to an appropriate sound production task and forming delayed discriminations upon his articulations. In the final phase of discrimination training, the student is presented with articulation continua in which a series of articulations of a phoneme pass progressively from distortions to correct production or are sequenced in the reverse. The student is faced with the task of determining whether he is hearing a correction or error sequence. Initial sequences posses large intervals facilitating the discrimination of change direction; subsequent sequences utilize smaller intervals.

SOUND PRODUCTION TRAINING

The sound production training units begin with efforts to increase the student's ability to discriminate the motor pattern he uses in the formation of his misarticulated sound. Slide and film supplements are incorporated into the program to permit the more effective visual apprehension of articulator positioning. The individual components of the motor act are separately enacted to insure response efficiency at a submolar level of performance. Component responses are practiced subsequently in slow sequences to establish transitional fluency within phonetic shift patterns. Consonant combinations which present frequent problems of blending, eg., plosive-vowel sequences, are taught as vocalic units.

In the development of the complete articulatory response both response matching and response shaping techniques are utilized. Response matching is consistently employed with continuant sounds. In this procedure the phoneme is pro-

duced by tape in a series of intervals. During each interval the student's attempts to match his own articulation to the stimulus by continuously varying and experimenting with his articulatory adjustment. The experimentation is guided by cueing the student to the articulatory structures and dimensions capable of yielding relevant change and by the provision of feedback by student-therapist monitoring.

Response shaping or response approximation techniques require the student to carry out a graduated motor progression under conditions of immediate reinforcement. The technique is most successful where the progression of responses are clearly specifiable and where the student is capable of interpreting the visual or proprioceptive feedback. The shaping sequences are first demonstrated by filmed presentation and a particular effort is made to clarify the cues which may be used to determine the correctness of the response sequence.

Since the elicitation of a correct articulation does not insure the rapid extinction of the misarticulated response, response competition obtains for varying time periods. We have attempted to reduce the probability of the misarticulated response being formed to intentional and phonetic context cues by altering the usual reinforcing stimuli. This is accomplished by having the student practice his new articulatory response under conditions of unvoiced speech. The absence of the usual auditory feedback forces attention to proprioceptive aspects of the new response, while eliminating the auditory component to which the prior misarticulated response had become associated. Voiced speech is gradually reinstated, but speech is deliberately slowed-again altering the normal pattern of stimulus reinforcement. As the associative strength of the new response increases, speech speed is increased until a normal rate is attained.

With the development of sufficient response probability for the new articulation, extensive monitoring practice is introduced. A number of role playing and simulation activities have been devised to promote a naturalistic context for speech production. Recording, playback, and student monitoring is emphasized as a final phase in the automatization of the new articulation.

MECHANICS OF LABORATORY OPERATION

The equipment used in the laboratory is as follows:

A Table Top Console:

This unit consists of E.F.I. tape recorder and console with eleven (11)accompanying headsets /w boom mikes. The console functions as the junction box which interconnects ten children and supervising adult. The console provides flexible communication control for the student who may speak and/or record with selected students during the program's operation.

Note: The Table Top Laboratory and its dual use.

The E.F.I. Table Top Lab Console:

Its use is twofold: It introduces the program to the children and is used with those children not ready for independent instruction. In its use the console presents the format of the program, familiarizes the children with it, introduces them to the new vocabulary, and presents an orientation on the anatomical structures and their physiological function in the production of speech sounds. When this first phase of the program is successfully completed, the children are then advanced to one of four stations where they proceed to work in the self-instructional phases of the program. These four Audio Notebooks w/ 2-3 Headsets /w Boom Microphone for each Notebook, and spaced around the Laboratory room where 1, or 2, or 3 children work independently at each of the four stations.

Four Audio Notebooks /w Headsets /w Mikes:

This is the tape recorder which enables one-to-three children to connect into the program to listen, record, rewind, and monitor their responses instantaneously.

Speakers and Eight (8) Listening Devices with Jack:

Should a mechanical breakdown occur, the Speaker or the Listening Devices can carry on the program till servicing to equipment is rendered, thereby preventing any interruption of the program.

Although the responsibility of the overall operation of

the Laboratory belongs to the supervising Speech Pathologist, direct day to day supervision is carried out by Laboratory Aides. Such aides are trained on the local level by the Speech Pathologist. They learn the operation and minor repair activity of the electronic machinery, familiarity with the instructional materials, the technique of scheduling large numbers of pupils, recording daily progress of subjects and generally keeping order and a continuous movement of the total process. The aides also monitor the initial aspects of the program which serves as an introduction for the pupil to the methodology and format of the new automated experience. They clarify and interpret the self instructional introductory material designed for the beginning pupils and decide when the subjects are proficient enough to graduate into the non-monitored aspects of the automated self instructional program.

Subjects were run three times weekly in ½ hour sessions each over a period of several months. Absences, tardiness, withdrawal from school and late starters added some contamination to the experimental design. Treatments of shorter duration, but more intensified and "zeroed" in on one specific sound, in the future, will alleviate somewhat the extent of this particular variable.

PROGRAM EVALUATION: OBJECTIVES

In introducing the programs on articulation and discrimination for trial to the population of children served by the Laboratory, we considered it to be in the interests of the students to combine the program, in its first year, with one of the traditional speech therapy. Thus, all students in this initial application of the experimental program received, concurrently, 2 periods a week of conventional remediation from an experienced speech therapist.

An extensive evaluatory design for examining the independent treatment effects of the experimental program in the coming semester has been presented. In view of the confounding of treatments and revisions of the program carried out during the past year, it would perhaps be more appropriate to attempt a process analysis on single subject studies than a formal test of treatment gains. Nevertheless, we have sought to perform a limited experiment to determine the contribution of the automated articulation and discrimination programs as

a form of adjunctive treatment.

We have hypothesized that as a consequence of the program's emphasis upon self-monitoring experiences, and the generalization and automatization of articulatory corrections the addition of the program to traditional therapy will result in:

a) The attainment of significantly greater gains than those achieved by subjects receiving traditional therapy alone, where gains are measured by standard, structured response testing of articulatory performance.

b) The attainment of significantly greater gains than those achieved by subjects receiving traditional therapy alone, where gains are measured by error reduction scores for samples of connected speech generated under conditions of naturalistic free response.

c) A significant differential treatment effect such that subjects with high ability to correctly imitate their spontaneously defective sounds will manifest the largest gains for all forms of articulatory testing. This is to argue that traditional therapy is weakened in producing consistence of articulation in subjects who demonstrate the necessary response capability.

PROCEDURE

SUBJECTS:

Of the 110 elementary grade students with speech disorders processed through the Laboratory in the first year of its operation, forty-six were selected for studies designed to test specific hypotheses related to the objectives of the program. For thirty of these students, the primary problem was that of uncomplicated articulatory dyslalia. The remaining sixteen students were first graders assigned to the Laboratory program to examine the relevancy of the program to the development of phonic and auditory discrimination skills involved in initial reading instruction.

The thirty students referred for articulatory problems were part of a larger group of students treated for such difficulties. Those accepted for inclusion in the study sat-

isfied multiple criteria of selection: all had obtained intelligence quotients above 85 in administrations of the California Test of Mental Maturity, none exhibited significant hearing losses, ie. losses equal or greater than 20dB; none provided evidence of gross neurological involvement as clinically inferable from performances on the Osertsky Test of Motor Proficiency and the Bender-Motor Gestalt Test; and in no case did dental malocclusions or other structural conditions constitute a basis of speech difficulty.

Each student demonstrated multiple errors of articulation upon the test described below. The primary source of errors were distortions of consonantal phonemes. Each error was followed by a stimulability check and ratio of corrected performances to errors were computed.

Subsequent to their selection, the students were administered the Wepman Auditory Discrimination Test and a test designed to permit an estimate of the number of articulatory errors produced in connected speech under conditions more closely approximating a naturalistic context. In this procedure students were requested to respond with a bried imaginative story or a descriptive elaboration to a selection of stimulus pictures drawn from the Peabody Language Development Kit. Responses were elicited and tape recorded by a speech therapist after the completion of activities designed to create a degree of rapport and the stimulation of verbal productivity. Ten, one minute samples were randomly abstracted from each student's tape and scored for the frequency of articulatory errors. To determine inter-rater agreement, product-moment correlations were computed for the scoring of two trained therapists or pre and post test samples. Correlations of .83 and .85, respectively, were obtained. Raw scores of articulatory error frequency for free response speech, however, cannot be compared between occasions since they are dependent upon the number of words emitted containing phonemes typically misarticulated by the subject. To achieve comparability, phonemes with high error rate probabilities were identified for each subject from the results of structured response testing. Typescripts were then prepared of the subject's samples of connected speech and a total frequency count of the occurrence of error-associated phonemes in the arrestor or terminator syllable position was determined. From the data, it was possible to compute a fraction representing the subject's error rate for a specific phoneme in a specific phonemic context. Averaging error rates across misarticulated phonemes and convert-

ing to a base of one hundred provided an estimate of the frequency of misarticulation for every hundred occasions in which the subject uses words containing phonemes he has misarticulated in prior testing. Changes in error-frequency constituted a dependent variable for this study.

A more reliable, if less generalizable dependent measure of change was obtained from a comparison of error counts produced by a structured test of articulation, representing a highly modified and foreshortened version of the Picture and Sentence Deep Test of Articulation. The test measures articulatory performance for twelve consonantal phonemes in a total of fifty-one phonemic contexts. The following sounds were evaluated: /r/, /s/, /θ/, /ð/, /v/, /z/, /ʃ/, /ʒ/, /tʃ/, /dʒ/, /f/, and /ʒ/. Responses were evoked by a visual stimulus and by imitation of the examiner. The test also included a procedure for determining the efficiency of self-monitoring, in which the subject was asked to make an immediate discrimination with respect to the correctness of his performance. Inspection of the data, however, revealed that pre-emptive response sets had developed which invalidated that portion of the data for the purposes sought.

Articulation scores were summed totals of errors, differentially weighted by error type (substitution, omission and distortion), a procedure which related to the empirical evidence on the relative contribution of error forms to the intelligibility of connected speech (Jordan,1960). Inter-rater agreement, for two raters, experienced in deep testing procedures, and trained to increase error definition consensus, yielded percentages of agreement of 89.1 and 92.4 for pre-and-post testing evaluations. Rater disagreement was confined to the category of distortions-training involved the isolation of items producing disagreement from taped responses to the articulation test drawn from students excluded from consideration during initial screening. For particular phonemes, an effort was made to arrange a continuum from error free articulation to unambiguous distortion. A conservative definition of articulations to be scored as incorrect was then established cojointly by the raters utilizing specific continuum responses as reference or marker indices.

The stablility of articulatory performance reflected in the responses to testing was examined by retesting of the thirty experimental and control subjects two weeks after their

initial evaluation. The ratings, from taped responses, produced a Pearson product moment correlation of .86, with patterns of inconsistency largely the consequence of variation among subjects with high stimulability socres, ie., subjects capable of correct articulatory imitation.

SUBJECT ASSIGNMENT:

Although performance inconsistency was not incorporated into the experimental design, the associated factor of stimulability, a moderator variable of treatment response (Sommers 1967) appeared to warrant a consideration of its independent and interactional affects. On the basis of stimulability ratios, students were categorized by median division into high and low groups. Within each group, subjects were randomly assigned to treatments. The assignments resulted in a treatment group with a mean age of 8.1 years and a mean I.Q. of 112; the corresponding value for controls averaging 8.4 years and I.Q. 108, respectively. Both groups included students from the first to fourth grades. Two students were lost to the study by transfer and data analysis was performed on a sample size of twenty-eight.

RESULTS:

The analysis of variance for treatment gains indicates both a significant treatment effect and a significant interaction for stimulability treatment on the critieron of improvement for the structured laboratory test of articulatory performance. The results are set forth in Table I. The mean improvement for subjects receiving laboratory program training supplemental to traditional therapy is 31.2; that for those receiving traditional therapy alone is 22.5. Gains, however, are also influenced by stimulability scores. Subjects with low stimulability demonstrate a mean gain of 31.0; those with high stimulability scores show mean gain scores of 22.7. The interaction of stimulability with treatment is apparent in the comparison of treatment effects within stimulability groups. Within the low stimulability group, experimental treatment produces a mean gain of 32.4, traditional treatment a gain of 29.6. Among high stimulability subjects the corresponding gain scores are 30.0 and 15.4.

The analysis of variance of articulation difference scores for samples of free response, connected speech similarly demonstrates a significant treatment effect and a significant effect.

ascribable to stimulability status. Interaction, however, is non-significant.

The mean gain for students receiving supplemental laboratory work is 25.7; for those receiving traditional therapy alone, the gain average is 15.6. Despite the non-significant interaction, differences between treatments is greater among high stimulability subjects (19.7 to 8.3) than among low stimulability subjects (31.7 to 22.9). Again, stimulability is an evident factor in treatment gains. High stimulability subjects across treatments average gains of 14.2; low stimulability subjects obtain gains equaling 27.2.

DISCUSSION:

We have indicated our reasons for regarding the validity studies we have undertaken as possessing rather restricted implications. It is, nevertheless, of interest to note the nature of the contribution effected by the laboratory program when offered as an adjunctive or correlative to traditional speech therapy. In this ancillary role, the laboratory program demonstrates its ability to enhance the response formation process, ie., the process of training the subject to emit sounds he was previously unable to correctly articulate. More significantly, the data of the study suggests that the laboratory program tends to effectuate gains where traditional therapy is least successful. The apparent ability of the laboratory program to generate greater performance consistency from subjects who reveal conditional response capacity (high stimulability) and to bring about the transferance and stabilization of such response in connected and spontaneous speech is, if replicable, of some significance.

It is, of course, impossible from the present data, because of the combining of the laboratory and traditional treatment programs, to answer questions addressed to the independent effectiveness of the laboratory program. Nevertheless, some subjects in the laboratory program received training on individual phonemes, which at the time, were not being considered during their traditional treatment sessions. We charted the progress of such subjects in an attempt to establish typical learning curves for both the discrimination and sound production phases of the program and more generally to follow the vicissitudes of the subject's efforts to respond to the automated presentation of the program. Our observations have led us to the following conclusions:

a) The programs produce measureable gains and inter-lesson as well as intra-lesson improvement may be noted. Curves for the development of discriminatory skill, however, while positively accelerative have low slope values and improvement appears to be the consequence of learning to orient to the appropriate contrast dimensions and of a progressive ability to differentiate increasingly fine unit boundaries of phonetic groupings.

b) The opportunity to branch students demonstrating high rates of error to tasks of reduced difficulty or to alternative approaches is of considerable significance since maintenance of excessive demand often produces signs of abrupt performance deteriorations. Consistently low error rates for linear programming, comparable to that achieved in some of the cognitive domains, would appear difficult of accomplishment in the area of articulation and auditory discrimination training.

c) The use of monitoring equipment, automated procedures, and multi-media devices creates an ambience which is particularly instrumental in gaining acceptance from the self-conscious, the low confident, and the resistant child. For many of the boys in the program the technology of the Laboratory was viewed as a saving grace from an activity which stimulated little pre-conceived enthusiasm.

d) The contribution and capacities of paraprofessional aides has been underestimated. Properly trained, they are capable of assuming a diversity of responsibilities and their presence not only permits the treatment of considerable larger numbers of students than would be otherwise the case, but it allows for a considerable greater range of remediational activities to be undertaken.

SUMMARY:

A speech therapy program offering automated and programmed instruction in sound production and auditory discrimination has been described. In measure self-teaching and in measure designed to permit its administration by the assistance of paraprofessional aides operating under the direction of a speech therapist. The program is an attempt to create a wider and more flexible treatment service.

Although presented in the past year as a supplement to

traditional treatment, an effort was made to evaluate in a limited study the contribution of the experimental program to the accomplishment of speech therapy goals. An examination of the effects of providing the laboratory program as additional training indicated that the program was capable of increasing the effectiveness of instruction with respect to the primary objectives of speech therapy--the development of correct articulatory responses and the realization of their use in connected, naturalistic speech. The achievement of the latter may be a consequence of the application of certain learning derived techniques for the counter-conditioning of responses and the outcome of the extensive and varied self-monitoring practice afforded by the program. Informal observations have also been rendered in describing individual student responses and learning patterns. While not evidential in the manner of formal testing, such observations similarly have provided support for the belief that the program represents a significant instrumentality for the accomplishment of treatment objectives.

TABLE 1. Analysis of variance of articulation difference scores (structured articulation testing)

SOURCE	df	MEAN SQUARE	f
Treatment	1	531.5	29.0*
Stimulability	1	480.5	26.3*
Treatment x stimulability	1	240.3	13.1*
Error	25	18.3	
Total	28		

TABLE 2. Analysis of variance of articulation difference scores (free response testing)

SOURCE	df	MEAN SQUARE	f
Treatment	1	1235.5	40.4*
Stimulability	1	720.1	23.5*
Treatment x stimulability	1	11.7	
Error	25	30.6	
Total	28		

*$p < .01$

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